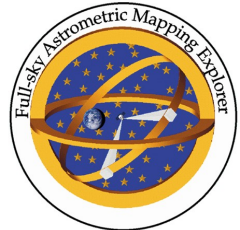




EMI Requirements

Michael Obara
EMI/EMC Engineer
NRL
202-404-4390
obara@ssdd.nrl.navy.mil



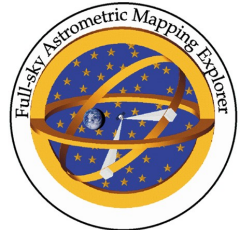
Top Level Requirements

- **Modified MIL-STD-461C Part 3**
 - **Conducted Emissions**
 - » CE01 30 Hz - 20 kHz
 - » CE03 20 kHz - 50 MHz (Narrowband Only)
 - » CE06 10 kHz - 40 GHz Antenna Terminals
 - **Conducted Susceptibility**
 - » CS01 30 Hz - 50 kHz
 - » CS02 50 kHz - 400 MHz
 - » CS03 15 kHz - 10 GHz Antenna Terminals
 - » CS04 30 Hz - 20 GHz Antenna Terminals
 - » CS06 Time Domain, Spike
 - **Radiated Emissions**
 - » RE02 14 kHz - 18 GHz (Narrowband Only)
 - **Radiated Susceptibility**
 - » RS03 10 kHz - 18 GHz
 - **Electrostatic Discharge (ESD)**



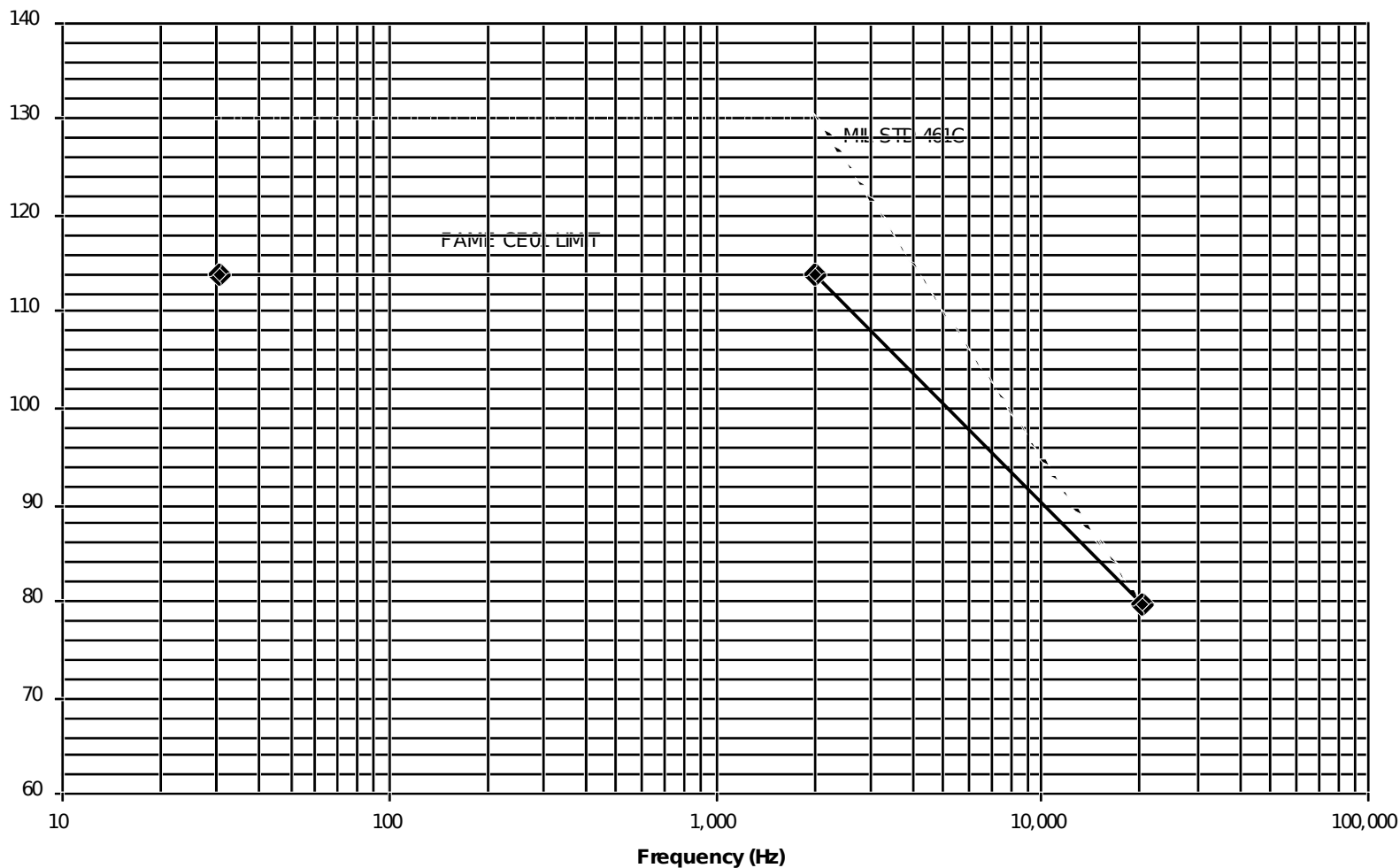
CE01 Detailed Requirements

- **CE01 - 30 Hz to 20 kHz**
 - **Modified MIL-STD-461C Limit**
 - **More stringent due to lower CS01/CS02 Injection Levels**
 - **Maintains 20dB Safety Margin between CS01/CS02**
 - **MIL-STD-462 Test Method**



CE01 Detailed Requirements (continued)

LIMIT FOR CE01 NARROWBAND EMISSIONS





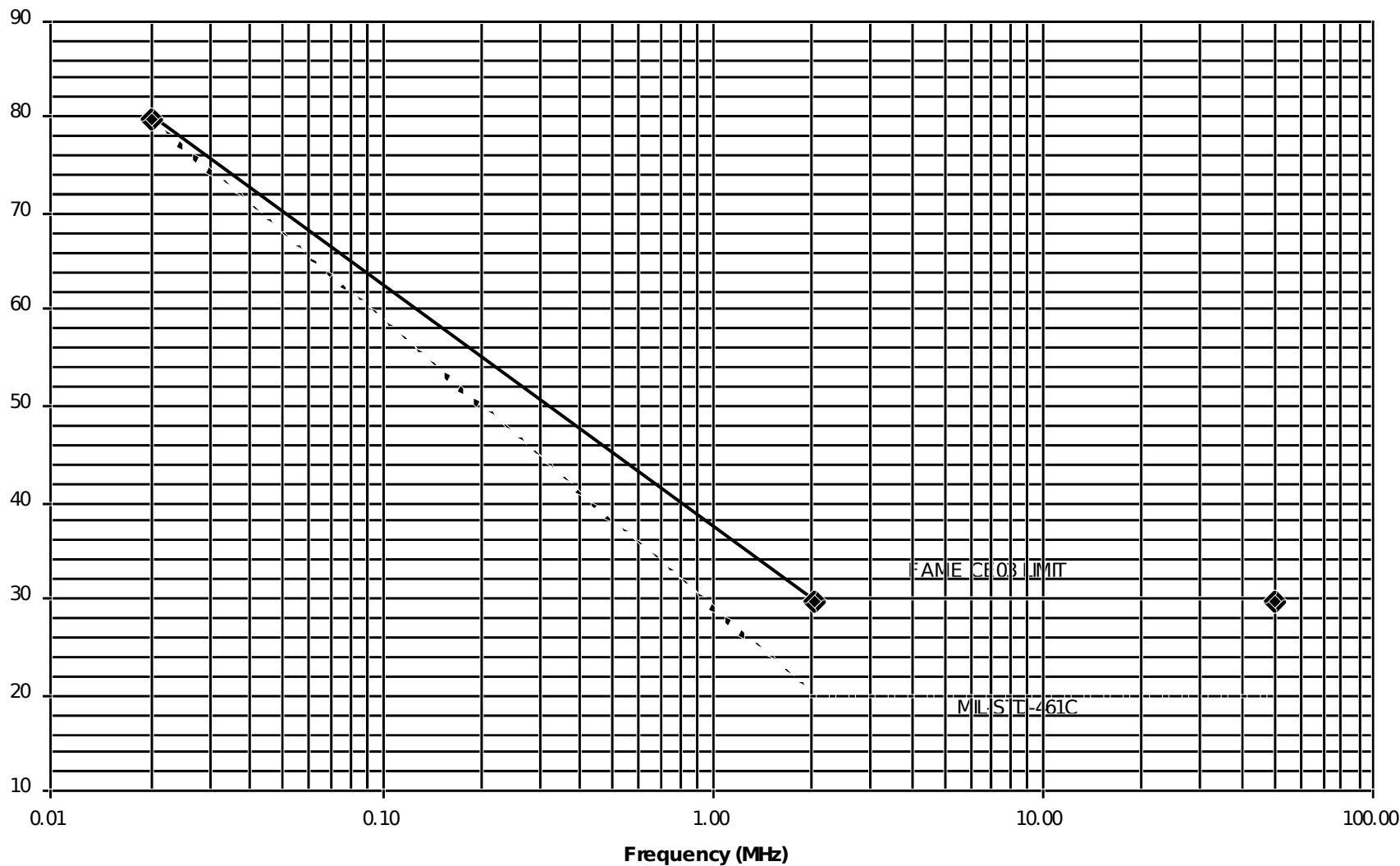
CE03 Detailed Requirements

- **CE03 - 20 kHz to 50 MHz (Narrowband Only)**
 - **Modified MIL-STD-461C Limit**
 - **Relaxed Limit**
 - **Maintains 20dB Safety Margin between CS01/CS02**
 - **MIL-STD-462 Test Method**



CE03 Detailed Requirements (continued)

LIMIT FOR CE03 NARROWBAND EMISSIONS





CE06 Detailed Requirements

- **CE06 - 10 kHz - 40 GHz Antenna Terminals (Narrowband Only)**
 - **Limited Applicability**
 - **MIL-STD-461C Limit**
 - **Receivers: 34 dB μ V**
 - **Transmitters and Amplifiers (Standby Mode): 34 dB μ V**
 - **Transmitters and Amplifiers (Transmit Mode): Harmonics, except the second and third, and all other spurious emissions shall be 80 dB down from level at the fundamental. The second and third harmonics shall be suppressed $50 + 10 \log p$ (where p = peak power in watts, at the fundamental) or 80 dB, whichever requires less suppression.**
 - **MIL-STD-462 Test Method**



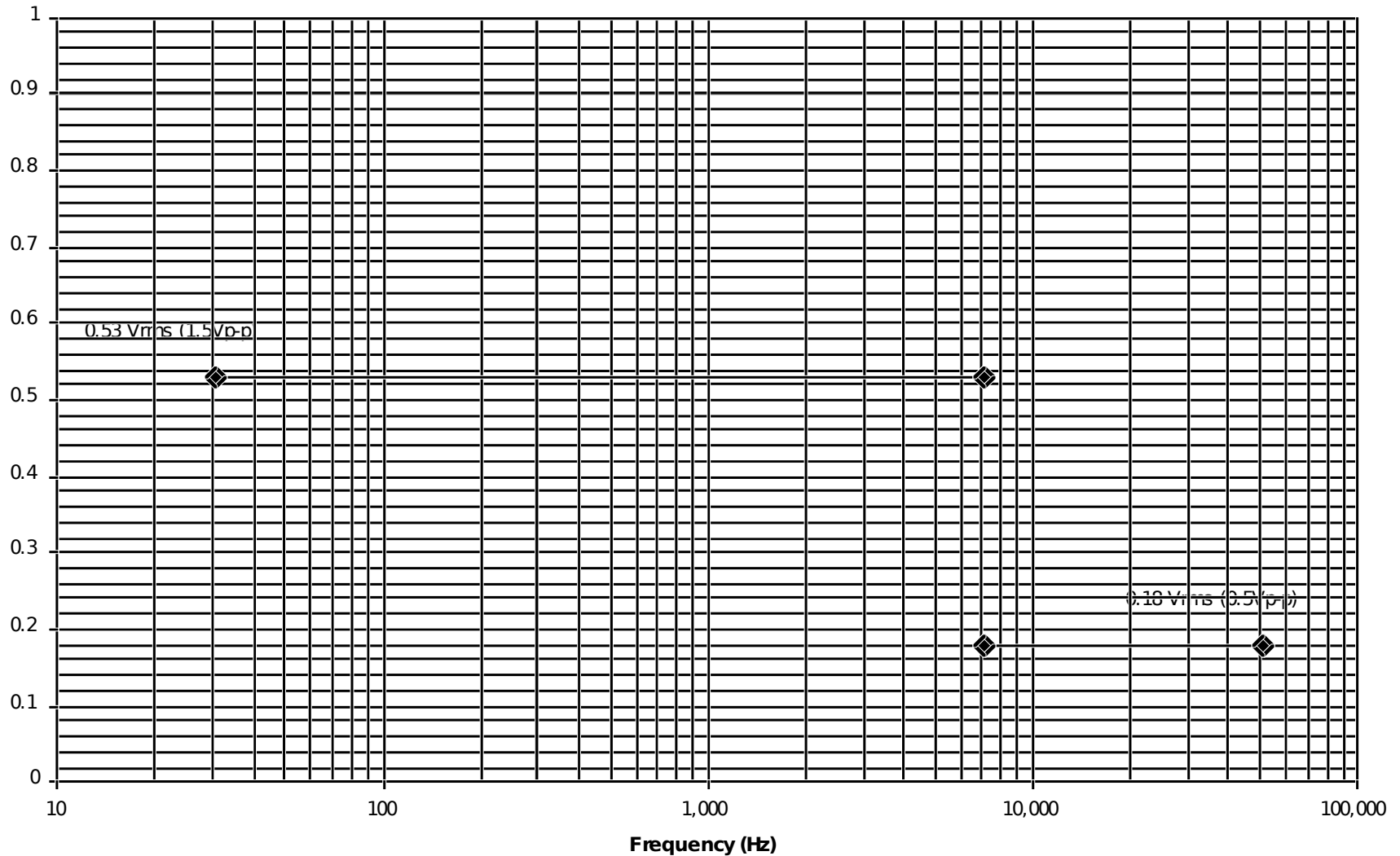
CS01 Detailed Requirements

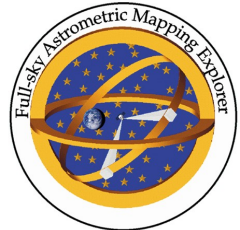
- **CS01 - 30 Hz to 50 kHz**
 - **Modified MIL-STD-461C Levels**
 - **Relaxed Limit Maintains EMI Safety Margin**
 - **CS01 Levels are 20dB above simulated worst case power bus ripple level analysis**
 - **Requirement is also met if the CS01 power source, adjusted to dissipate 50 Watts into a 0.5 Ohm load cannot develop the required Injection voltage**
 - **MIL-STD-462 Test Method**



CS01 Detailed Requirements (continued)

CS01 VOLTAGE INJECTION LEVELS





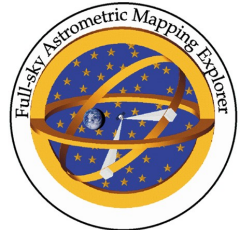
CS02 Detailed Requirements

- **CS02 - 50 kHz to 400 MHz**
 - **Modified MIL-STD-461C Levels**
 - **0.18 Vrms (0.5 Vp-p) from a 50 Ohm source**
 - **Relaxed Limit Maintains Safety Margin**
 - **CS02 Levels are 20dB above simulated worst case power bus ripple level analysis**
 - **Requirement is also met if the CS02 power source, adjusted to dissipate 1 Watts into a 50 Ohm load cannot develop the required Injection voltage**
 - **MIL-STD-462 Test Method**



CS03 Detailed Requirements

- **CS03 - 15 kHz to 10 GHz Antenna Terminals**
 - **Limited Applicability**
 - **MIL-STD-461C Levels**
 - **Signal Generator #1: 66 dB above the level required to obtain the standard reference output. When the test frequency is between either 200 to 400 MHz or 2 to 25 MHz, the level shall be 80 dB above the reference level, but the generator output shall not exceed 10 dBm.**
 - **Signal Generator #2: 66 dB above the level required to obtain the standard reference output, but the generator output shall not exceed 10 dBm.**
 - **MIL-STD-462 Test Method**

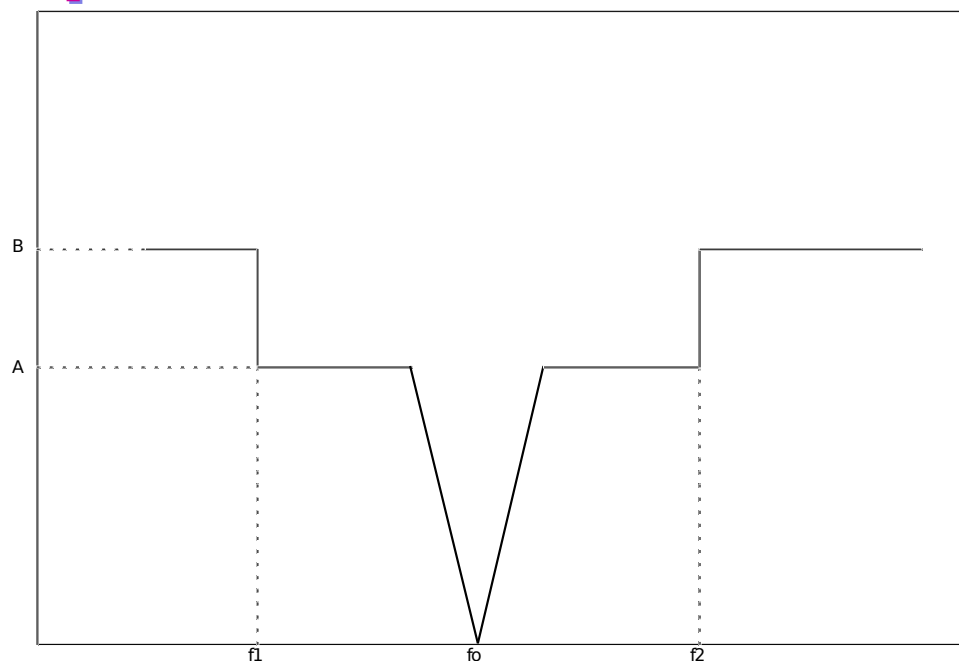


CS04 Detailed Requirements

- **CS04 - 30 Hz to 20 GHz Antenna Terminals**
 - **Limited Applicability**
 - **MIL-STD-461C Levels**
 - **0 dBm injection signal when the test frequency is outside the tuning range of the receiver**
 - **80 dB above the level required to obtain the standard reference output when the test frequency is within the tuning range.**
 - **The passband between the 80 dB points receiver selectivity curve are excluded.**
 - **MIL-STD-462 Test Method**



CS04 Detailed Requirements (continued)



- **f_o = Receiver tuned frequency**
- **f_1 = Lowest tunable frequency**
- **f_2 = Highest tunable frequency**
- **A = 80 dB above the level required to obtain the standard reference output when the test frequency is within the tuning range**
- **B = 0 dBm**



CS06 Detailed Requirements

- **Time Domain Spike Test**
 - **Modified MIL-STD-461C Levels**
 - $|E1| = 2 * \text{Line Voltage}$, $t1 = 10$ microseconds, 6-10 pps
 - $|E2| = 2 * \text{Line Voltage}$, $t2 = 0.15$ microseconds , 6-10 pps
 - DC power leads and Return shall be tested
 - Each Spike shall be superimposed on the powerline voltage
 - Positive and Negative spikes required
 - **MIL-STD-462 Test Method**



RE02 Detailed Requirements

- **RE02 - 14kHz to 18 GHz (Narrowband Only)**
 - **Modified MIL-STD-461C Part 3, Curve #1**
 - **Extend Limit out to 18 GHz**
 - **Add Notch in Limit for RF Uplink Frequencies (2015 - 2130 MHz)**

- **MIL-STD-462 Test Method**

Transmitter Power (200 W)

53.0 dBm

Line & Diplexer Loss
dB

-2.0

Antenna Gain (10 m)
dBi

44.0

Free Space Loss (Geosynch at 5 deg elev)
-190.3 dB

Atmosphere Loss (5 deg)

-0.5 dB

EIRP at Uplink Antenna
dBm/m²

-95.8

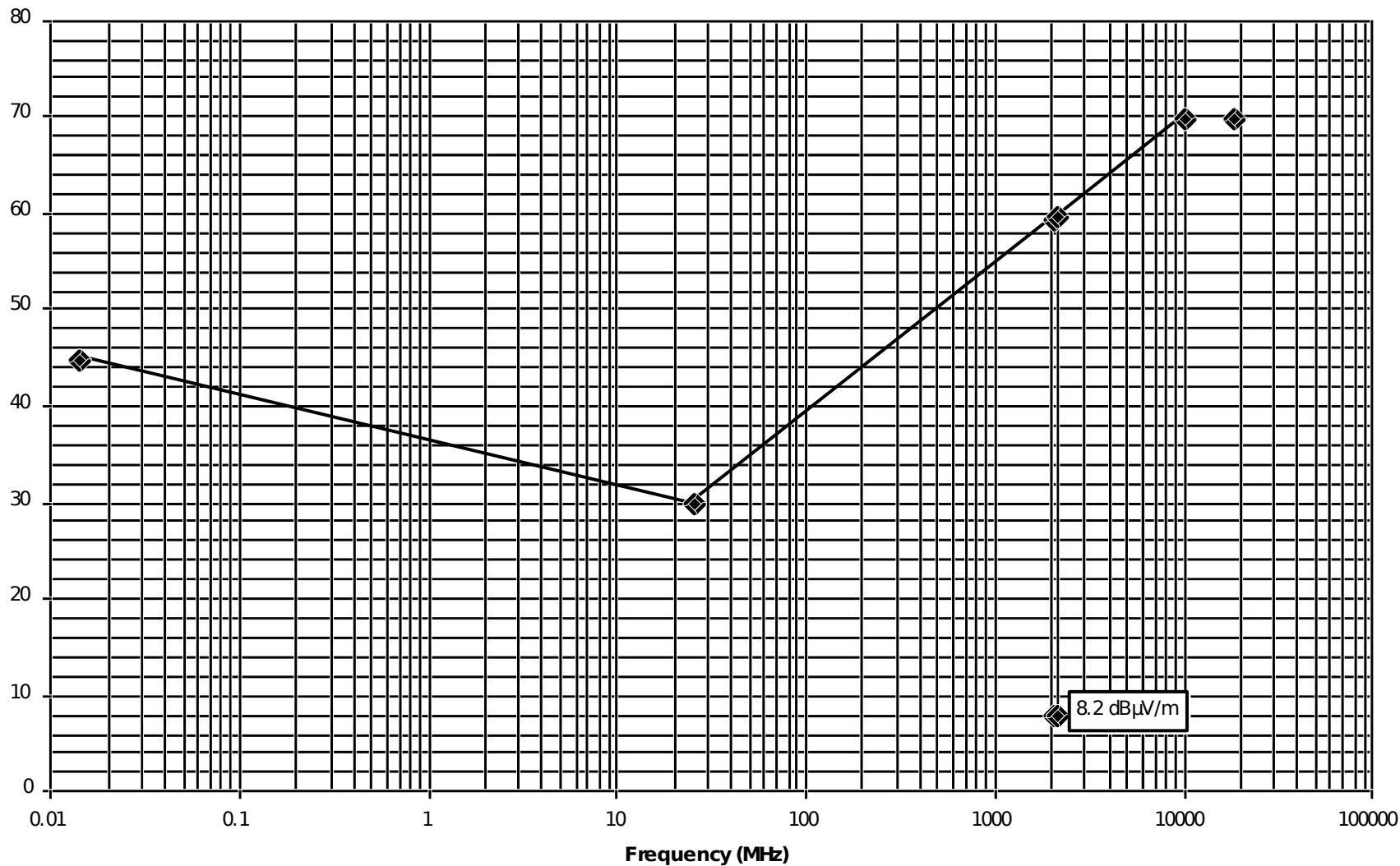
|E| at Uplink Antenna
dBμV/m

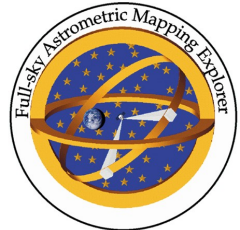
20.0



RE02 Detailed Requirements (continued)

LIMIT FOR RE02 NARROWBAND EMISSIONS





RS03 Detailed Requirements

- **RS03 10 kHz - 18 GHz**
 - **Modified MIL-STD-461D RS103 Levels**
 - **20 V/m, 1 kHz Pulse Modulation**
 - **40 V/m Notch, 2200 to 2300 MHz, 1 kHz Pulse Modulation**
 - **Downlink Transmitter Frequency**
 - **MIL-STD-462 Test Method**

Transmitter Power (20 W) 43.0 dBm

Antenna Gain

0 dBi

EIRP at Uplink Antenna 43.0
dBm/m²

$|E|$ at 1 meter from Transmit Antenna

25 V/m

$|E| = \text{SQRT}(30 * \text{EIRP})$

Safety Margin 3 dB

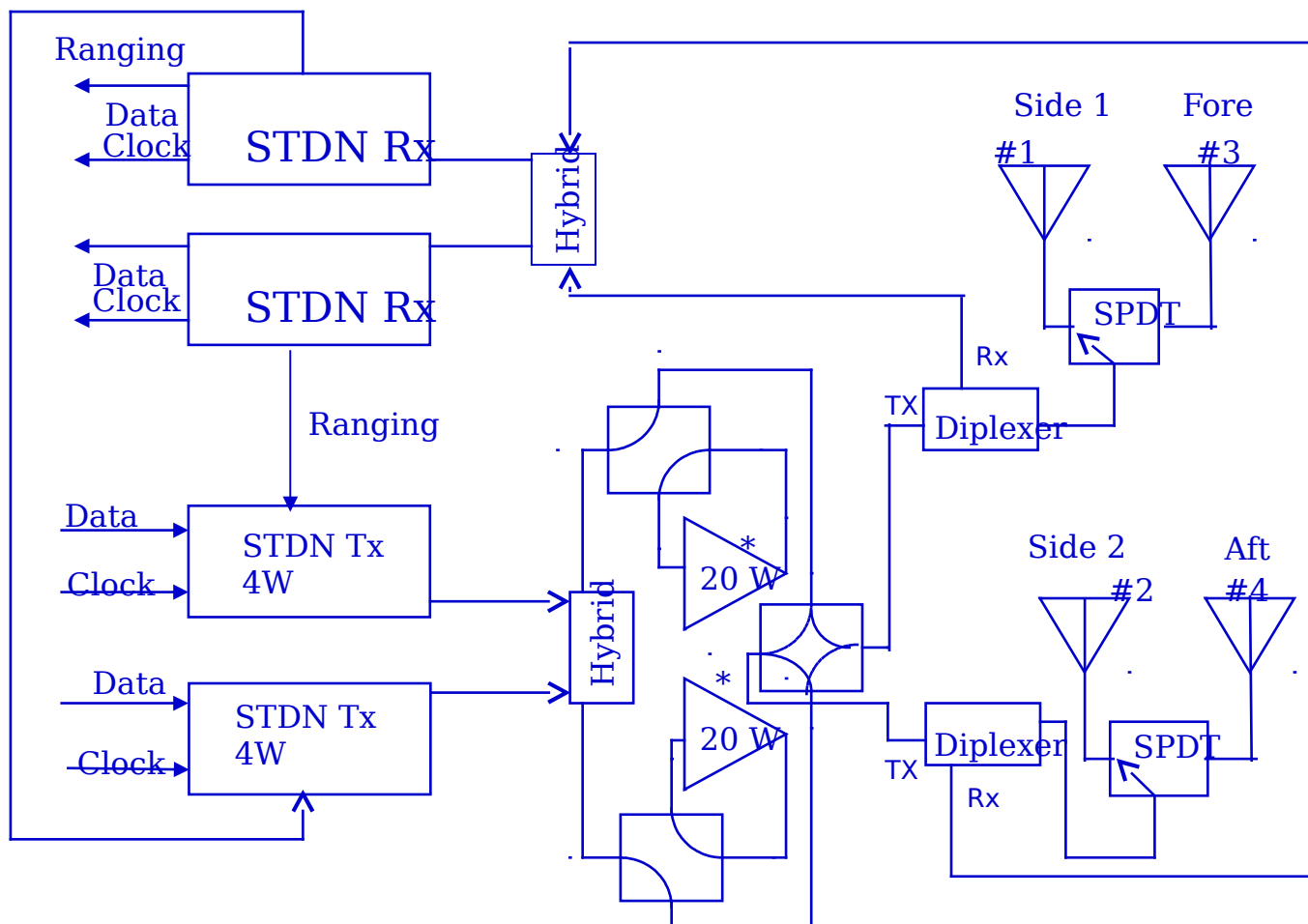


ESD Detailed Requirements

- **TBD**



Backup



- Power amps operated separately during normal operation. Safety interlock and internal limiting prevent accidental overstress of the amplifier in the event that the output is connected to the input with DC power applied.



Backup

